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Adaptation and yield of *Glycine Max L.*, in the agroecological conditions of the Quinindé canton in Ecuador

Adaptación y rendimiento *de Glycine Max L.*, en las condiciones agroecológicas del cantón Quinindé en Ecuador

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Abstract

The present research was carried out on the adaptation and yield of Glycine Max l., in the agroecological conditions of the Quinindé canton of Ecuador, under the geographical coordinates: 00°13'33'' north latitude and 73°26'00'' west longitude, to determine the adaptation and yield of 15 soybean materials to these agroecological conditions. Fifteen treatments and three replications were applied, using InfoStat software for significance testing. In the experiment, soil analysis, mechanized field preparation, sowing, weed control, fertilization, phytosanitary controls and harvesting were carried out. The agronomic parameters evaluated were: plant height, branches per plant, days to flowering, bearing height, pods per plant, days to maturity, days to harvest, seeds per pod, seeds per plant and economic analysis. The results indicate a good adaptation of all treatments; specifically their earliness, loading height, grain weight and yield. It is concluded that the adaptation and yield processes will contribute significantly to the formulation of new studies, considering the growing demand for products made from soybeans, thus benefiting producers and consumers.

Keywords: crop, soybean, adaptation, yield, yield, agroecologies

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Resumen

La presente investigación se realizó adaptación y rendimiento de Glycine Max l., en las condiciones agroecológicas del cantón Quinindé de Ecuador, se abordó bajo las coordenadas geográficas: 00°13´33´´ de latitud norte y 73°26´00´´ de longitud oeste, para determinar la adaptación y rendimiento de 15 materiales de soya a estas condiciones agroecológicas. Se aplicaron 15 tratamientos y 3 repeticiones, empleando el software InfoStat para las pruebas de significancia. En el experimento, se realizó un análisis de suelo, preparación mecanizada del terreno, siembra, control de malezas, fertilización, controles fitosanitarios y cosecha. Se evaluaron los parámetros agronómicos: altura de planta, ramas por planta, días a floración, altura de carga, vainas por planta, días a maduración, días a la cosecha, semillas por vaina, semillas por planta y el análisis económico. Los resultados indican una buena adaptación de todos los tratamientos; específicamente su precocidad, altura de carga, peso de grano y rendimiento. Se concluye que los procesos de adaptación y rendimiento contribuirá significativamente en la formulación de nuevos estudios, considerando la creciente demanda de productos elaborados a base del grano de soya, beneficiando de esta manera a productores y consumidores.

Palabras clave: cultivo, soya, adaptación, rendimiento, agroecologías

Introduction

Soybean is an oilseed of world demand whose potential is not being considered in Ecuador. It is an important crop for the producers of the Ecuadorian coast, considering the characteristics of the plant and the planting cycles, for a rotation with grasses such as corn and rice. Soybean production is an important crop in the provinces of the central zone (Guayas, Los Ríos), where approximately 80% of the cultivated area is located.

In 2020, the national soybean area was 12,694 ha, with an average yield of 1.63 T ha^{-1}, ranging from 2.2 T ha^{-1} in Valencia to 0.53 T ha^{-1} in Urdaneta, in the province of Los Ríos. However, 76% of the producers have less than 5 ha, 10% have between 5.1 and 10 ha, and 14% have more than 10 ha. Of all producers, 19% use certified seed as planting material and 81% recycle seed. Pests and diseases are the main reported problem for production (63%), followed by drought (3%) and ash fall (82%); only 1% reported problems with seedling quality (14). Soybeans are composed of proteins, fats, carbohydrates and minerals. Proteins are located in the protein bodies or aleurone grains and fats in spherosomes, dispersed among the protein bodies, and up to 22% of oils and 42% of proteins can be extracted from them.

The Ministry of Agriculture and Livestock (2020), reports that since 2017 its monetary values for both purchase and sale have been decreasing. For 2019 there was a reduction of -4.8% compared to 2018, decreasing from $ 624.34 per MT to $ 594.35, this for sale. This report mentions that 64% of producers have not received training on the technical management of the crop, this would explain the high percentage of use of recycled planting material. Planting is generally done in June and harvesting takes place in October, and as is common in agricultural production, 82% of the production goes to intermediaries. Soil acidity and low temperatures have a more pronounced effect on nodulation and uptake of atmospheric nitrogen (Napoli et al., 2014). Soybean productivity and competitiveness is significantly influenced by the type of seed used in planting, according to MAG 65% of seed in Ecuador is recycled, which means that the farmer keeps part of the previous crop to plant in the next cycle, affecting the quality of the product. Choez-Quiroz et al. (2021), point out that it is necessary to develop specific actions to increase soybean production, taking into account that training, associated with the use of transgenic varieties, requires increasing the technological knowledge of the crop by producers, as an important pillar in the proper management of the crop.

According to the Survey of Surface and Continuous Agricultural Production (ESPAC) of 2020, Esmeraldas has an area with agricultural use of 447 447 hectares, of which 101 442 correspond to oil palm, 82 448 to the cultivation of cocoa, hard corn 1 746 and; cassava 114, in smaller amount area where vegetables, fruit trees and plantations of forest species are grown. Some studies indicate that several areas have the potential to develop soybean cultivation (Timbre, San Mateo, Tachina, Montalvo, Rioverde, among others), which is an excellent opportunity for farmers in these communities to improve their income and contribute to the expansion of this crop. However, the aforementioned problems and the lack of knowledge about the crop could generate difficulties in its promotion. Therefore, the National Oilseed Program (PRONAOL) of the National Autonomous Institute of Agricultural Research (INIAP) and the Technical University "Luis Vargas Torres" of Esmeraldas are investigating the adaptation of different planting materials to different ecosystems in the central zone of Esmeraldas. The work is part of the project "Procedures for strengthening and sustaining enterprises in the canton of Esmeraldas, Ecuador.

Materials and methods

The experiment was conducted in the Quinindé canton, geographic coordinates 00°13'33'' north latitude and 73°26'00" west longitude, Esmeraldas province, Ecuador. The average temperature is 26°C, average monthly rainfall is 93 mm and relative humidity is 86%. The soil is sandy loam with 31 ppm N (medium), 25 ppm P (high) and 0.13 meq/100 ml K (low). A pH of 5.8 (medium acid).

The seed of the soybean materials evaluated (10781, S-867, 10485, S-864, 10734, 10795, S-772, S-731, 10017, 10032, 10489, S-891) was provided by the Department of Oilseeds of the Litoral del Sur Experimental Station "Dr. Enrique Ampuero Pareja" of INIAP, considering as controls the commercial varieties INIAP-307, INIAP-308 and IJ-112-97. Due to the characteristics of the experimental area, a Completely Randomized Block Design (CSBD) with 15 treatments and three replications was applied. Statistical analysis was performed using InfoStat software.

Soil preparation consisted of two passes of plowing and one pass of harrowing. In addition, the field was furrowed, considering a separation between furrows of 45 cm and placing 15 seeds per linear meter at a depth of 3 cm. Thinning was carried out 12 days after planting, eliminating the plants that were outside the row and those that showed little vigor, leaving 12 plants per linear meter. Nitrogen fertilizer was applied 30 days after planting 60 kg N ha-1. For weed control, Pendimentalin (1 L ha-1) was used on the same day of planting, followed by mechanical controls every 15 days. Three irrigations were made, due to the humidity present in the soil. The pods were harvested according to the earliness of the materials evaluated.

The following variables were evaluated:

Days to flowering: The number of days from sowing until 50% of the plants of each treatment emitted flowers was counted. In addition, flower color was determined for each material.

Days to maturity: Days to maturity was considered from sowing until 95% of the plant leaves presented yellow color.

Days to harvest: The days elapsed from planting until the plants of each treatment reached harvest maturity were counted.

Plant height (cm): It was evaluated at 55 days, randomly selecting 5 plants in the net plot and measuring from the base of the plant to the apex. The result was averaged.

Height of load (cm): It was recorded at harvest, in the same plants as the previous variable, considering the height from the base of the soil to the point of insertion of the first pod.

Pods per plant: To evaluate this variable, the number of pods on five randomly selected plants in each treatment and replication was counted and then averaged.

Seeds per plant: To evaluate this variable, the number of grains of five plants taken at random from the useful area of the plot was counted and averaged.

Weight of 100 seeds (g): In each treatment and repetition, a sample of 100 seeds was weighed on a precision balance, the result was expressed in grams and the results were averaged.

Yield (kg ha-1): Yield was calculated based on the weight of grains harvested from the useful plot of each treatment and replicate; this value was expressed in kg ha -1.

Economic analysis: The reference costs and income generated by the treatments evaluated were established. The net benefits and the B/C ratio were determined.

Results

Days to flowering

The ANAVA for days to flowering shows that there are statistical differences among the materials evaluated. (Table 1)

Table 1. *Days to flowering in the adaptation and yield of Glycine max L., in the Quinindé canton.*

F.V.		SC gl	CM	F	p-value	
treatments	14<0	164.53	11.75	25.44	.0001	
repetitions	3.	73	2 1.	87 4	.04	0.0287
Error	12.93	28	0.46			
Total	44	181.20				

Tukey's test indicates that materials considered early flowered at 37 days (S-731, M-10017, M-10795, M-10781, S-864, S-772 and S-867), medium at 40 days (M-10032, IJ-112-97, M-10485, M-10489) and late at 42 days (S-891, INIAP 307, INIAP 308 and M-10734). These results agree with the reports of Cortez (2010), Guamán (2014) and Santillán (2010) (Table 2).

Tukey's test for days to flowering in the adaptation and yield of Glycine max L., in the Quinindé canton.

Treatments		Averages n		E.E.	
S - 731	36.67	3A		0.39	
M-10017	37.00	3A	0.39		
M-10795	37.33	3A	0.39		
M-10781	37.33	3A	0.39		
S - 864	37.33	3A	0.39		
S - 772	37.33	3A	0.39		
S - 867	37.33	3A	0.39		
M-10032	39.67	3	0.39	B	
IJ - 112 - 97		40.00	3	0.39	B
M-10485	40.33	3	0.39	B	
M-10489	40.33	3	0.39	B	
S - 891	41.33	3	0.39	B	
INIAP 307		41.67	3	0.39	B

INIAP 308	41.67	3	0.39	B
M-10734	41.67	3	0.39	B

Different letters indicate significant differences (p<=0.05).

Days to maturity

The ANAVA for days to maturity shows statistical differences among the materials evaluated. (Table 3)

Days to maturity in the adaptation and yield of Glycine max L., in the Quinindé canton.

F.V.		SC gl	CM	F	p-value	
Treatments	14<0	306.44	21.89	8.71	.0001	
Repetitions 6.		98	2	3.49	1.39	0.2661
Error 70.36	28	2.51				
Total 44	383.78					

Tukey's test indicates that the evaluated materials were presented in eight groups: M-10781 matured at 86 days, at 87 days (M-10017, M-10032); at 89 days (S-891, M-10795, S-731), at 91 days (S-864, S-867, INIAP 307, M-10734); at 93 days (IJ-112-97, M-10489); finally at 94 days (INIAP 308, S-772). This agrees with that reported in the adaptation evaluations carried out by Cortez (2010) and Santillán (2010); and partially with Holguín (2012); the local controls INIAP 307 and INIAP 308, are presented with a harvest cycle of 120 days (Table 4).

Tukey's test for days to flowering in the adaptation and yield of Glycine max L., in the Quinindé canton.

Treatments	Averages	n	E.E.	
M-10781	85.67	3A	0.92	
M-10017	86.67	3A	0.92	B

M-10032	86.67	3A	0.92	B			
M-10485	88.67	3A	0.92	B	C		
S - 891	89.33	3A	0.92	B	C	D	
M-10795	89.33	3A	0.92	B	C	D	
S - 731	89.33	3A	0.92	B	C	D	
S - 864	90.67	3	0.92	B	C	D	E
S - 867	90.67	3	0.92	B	C	D	E
INIAP 307	90.67	3	0.92	B	C	D	E
M-10734	90.67	3	0.92	B	C	D	E
INIAP 308	93.33	3	0.92	C	D	E	
IJ - 112 - 97	93.33	3	0.92	C	D	E	
M-10489	94.00	3	0.92	D	E		
S - 772	94.33	3	0.92	E			

Different letters indicate significant differences (p<=0.05).

Days to harvest

The ANAVA of days to harvest showed that there were significant differences among the treatments studied (Table 5). (Table 5)

Days to harvest in the adaptation and yield of Glycine max L. Merril in Quinindé Canton.

F.V. SC gl CM F p-value
Treatments 2823.78 201 14 .70 26.36 <0 .0001
Repetitions 7 .78 3 2 .89 0.51 0.6070
Error 214.22 28 7.65
Total 3045.78 44

The materials that were harvested at 111 days were: M-10781; at 112 days (M-10017, M-10032), at 113 days S-867; harvested at 119 days M-10485; at 122 days (S-891, S-731, M-10795, INIAP 307) at 123 days (S-864 and M-10734); at 133 days INIAP

308, IJ-112-97, M-10489 and S-772) . The behavior of the cores coincides with the reports of Cortez (2010), Guamán (2014) and Santillán (2010); and partially with the report of the Ministry of Agriculture and Livestock (2020) (Table 6).

Tukey's test for days to harvest, adaptation and yield of Glycine max L., in the Quinindé canton.

Treatments	Averages		n	E.E.		
M-10781	3A	110.67	1.60			
M-10017	3A	111.67	1.60	B		
M-10032	3A	111.67	1.60	B		
S - 867	3A	113.33	1.60	B	C	
M-10485	3	119.33	1.60	B	C	D
S - 891	3	121.67	1.60	C	D	
S - 731	3	121.67	1.60	C	D	
M-10795	3	121.67	1.60	C	D	
INIAP 307	3	121.67	1.60	C	D	
S - 864	3	123.33	1.60	D		
M-10734	3	123.33	1.60	D		
INIAP 308	3	133.33	1.60	E		
IJ - 112 - 97	133.33	3	1.60	E		
M-10489	3	133.33	1.60	E		
S - 772	3	133.33	1.60	E		

Different letters indicate significant differences (p<=0.05).

Height of plants (cm)

The ANAVA for plant height indicated that there were no significant differences between treatments, but there were significant differences between replicates. The coefficient of variation was 16.62 (Table 7).

Plant height, adaptation and yield of Glycine max L. in Quinindé Canton.

F.V.	SC	gl	CM	F	F	p-value
treatments	3366.60	14	240.47	1.97		0.0615
repetitions	1159.29	2	579.64	4.75		0.0167
Error	3416.10	28	122.00			
Total	7941.99	44				

The Tukey test showed a single range of significance and the materials that presented the lowest height were: S-891 (50.05 cm), S-867 (54.60 cm) and M-10795 (54.73). The greatest heights were obtained with M-10017 (74.27 cm), IJ-112-97 (75.07 cm) and M-10489 (81.13 cm). These results have lower values than other reports in other locations, which can be attributed to the differences in soil quality, which explains why statistical differences are observed between replicates as noted by Guamán (2010) (Table 8).

Tukey's test for plant height, adaptation and yield of Glycine max L., in the Quinindé canton.

Treatments	Averages	n	
S - 891	50.07	3	A
S - 867	54.60	3	A
M-10795	54.73	3	A
S - 864	58.40	3	A
M-10032	59.80	3	A
M-10485	65.33	3	A
INIAP 308	68.40	3	A
S - 731	69.60	3	A
M-10781	70.40	3	A
M-10734	71.00	3	A
INIAP 307	71.13	3	A

S - 772	73.00	3A
M-10017	74.27	3A
IJ - 112 - 97	75.07	3A
M-10489	81.13	3A

Different letters indicate significant differences (p<=0.05).

Load height (cm)

The ANAVA for loading height indicates that there is a significant difference between treatments and between replications. The coefficient of variation was 12.87 (Table 9).

Table 9. *Loading height, in the adaptation and yield of Glycine max L., in the Quinindé canton.*

F.V.	SC	gl	CM	F	p-value	
treatments	0.		611.54	14	43.68	5.22	0001
repetitions	92.47	2	46.23	5.52	0.0095	
Error	8	234.33	28	.37		
Total	938.34	44				

Tukey's test shows seven ranges of significance. In the first is M-10781 (15.67 cm); in the second range S-867 (17.53 cm) and S-891 (18.67 cm); in the third range M-10485 (19.13 cm), in the fourth range M-10795 (20.27 cm), S-772 (20.67 cm), M-10017 (21.33 cm), S-731 (22.53 cm), S-864 (24.07 cm); in the next rank are INIAP 308 (24.80 cm), IJ-112-97 (26.07 cm) and INIAP 307 (26.13 cm), then M-10734 (26.47 cm), in the last rank is M-10489 (28.40 cm). As can be seen, the INIAP 307 and INIAP 308 cores and the IJ-112-97 material have a loading height of around 25 cm, which is appropriate according to Guamán (2010), only being surpassed by M-10734 and M-10489 (Table 10).

Tukey's test for loading height, adaptation and yield of Glycine max L. in Quinindé canton.

Treatments	Averages	n				
M-10781	15.67	3	A			
S - 867	17.53	3	A	B		
S - 891	18.67	3	A	B		
M-10485	19.13	3	A	B	C	
M-10795	20.27	3	A	B	C	D
S - 772	20.67	3	A	B	C	D
M-10017	21.33	3	A	B	C	D
S - 731	22.53	3	A	B	C	D
S - 864	24.07	3	A	B	C	D
M-10032	24.40	3	A	B	C	D
INIAP 308	24.80	3		B	C	D
IJ - 112 - 97	26.07	3		B	C	D
INIAP 307	26.13	3		B	C	D
M-10734	27.47	3		C	D	
M-10489	28.40	3		D		

Different letters indicate significant differences (p<=0.05).

Number of pods per plant

The ANAVA for the number of pods per plant was not significant for treatments or replicates. The coefficient of variation is 31.58 (Table 11).

Table 11. *ANAVA for the number of pods per plant, in the adaptation and yield of Glycine max L., in Quinindé canton.*

F.V.	SC	gl	CM	F	F	p-value
treatments	833.83	14	59.56	0.80	0.6625	
repetitions	256.81128	2	.41 0	1.72	.1968	
Error	74 2085.85	28	.49			
Total	3176.49	44				

Tukey's test at 95% showed only one range of significance. The lowest number of pods per plant occurred in the treatments: S-891 (21 pods), M-10734 (22 pods), M-10017 (25 pods), S-772, M-10032 and S-867 (25 pods); IJ-112-97 and M-10795 (26 pods); M-10485 and S-731 (27 pods); S-864 (28 pods); INIAP 307 (29 pods); M-10781 and M-10489 (34 pods) and; the highest number of pods per plant was obtained in INIAP 308 (37 pods). As can be observed, materials M-10781 and M-10489, obtained similar values to the INIAP 307 and INIAP 308 controls, reported by Guamán (2010). However, a significant reduction in this parameter was observed for material IJ-112-97, which could be due to soil problems at the experimental site. (Table 12)

Table 12. *Tukey's test for the number of pods per plant, in the adaptation and yield of Glycine max L., in Quinindé canton.*

Treatments	Averages	n
S - 891	20.87	3A
M-10734	22.87	3A
M-10017	24.53	3A
S - 772	24.67	3A
M-10032	25.27	3A
S - 867	25.33	3A
IJ - 112 - 97	25.60	3A
M-10795	25.73	3A
M-10485	26.67	3A
S - 731	26.73	3A
S - 864	27.93	3A
INIAP 307	28.73	3A
M-10781	33.53	3A
M-10489	34.20	3A
INIAP 308	37.27	3A

Different letters indicate significant differences (p<=0.05).

Number of seeds per plant

The ANAVA for the number of seeds per plant indicates that there are no significant differences among the treatments studied. The coefficient of variation is 35.17 (Table 13).

Table 13. *ANAVA for the number of seeds per plant, in the adaptation and yield of Glycine max L., in Quinindé canton.*

F.V.	SC gl CM	F F	p-value		
treatments	0.3898.89	14	278.49	0.62	8234
repetitions	1220.54	2	610.27	1.37	0.2718
Error	12517.4828 447.05				
Total	17636.9144				

Tukey's test shows a single range of significance: S-891 (47 seeds), M-10032 (48 seeds), M-10734 (49 seeds), S-772 (52 seeds), M-10017 (56 seeds), S-731 (57 seeds), M-10795 (58 seeds), S-867 and S-864 (59 seeds); M-10485 (62 seeds); IJ-112-97 (63 seeds); INIAP 307 (65 seeds); M-10781 (69 seeds); INIAP 308 and M-10489 (78 seeds). As can be seen, M-10781 and M-10489 show a good potential for this zone (Table 14).

Table 14. *Tukey's test for the number of seeds per plant, in the adaptation and yield of Glycine max L., in Quinindé canton.*

Treatments	Averages	n
S - 891	47.47	3A
M-10032	48.20	3A
M-10734	48.53	3A
S - 772	52.27	3A
M-10017	55.93	3A

S - 731	57.33	3A
M-10795	57.73	3A
S - 867	58.80	3A
S - 864	59.40	3A
M-10485	62.47	3A
IJ - 112 - 97	62.87	3A
INIAP 307	65.47	3A
M-10781	69.20	3A
INIAP 308	78.00	3A
M-10489	78.13	3A

Different letters indicate significant differences (p<=0.05).

Weight of 100 seeds

The ANAVA for the weight of 100 seeds indicates that there are significant differences among the treatments studied. The coefficient of variation is 10.75 (Table 15).

Table 15. *ANAVA for the weight of 100 seeds, in the adaptation and yield of Glycine max L., in Quinindé canton.*

F.V.	SC	gl	CM	F	F p-value
treatments	66.31	14	4.74	2.68	0.0127
repetitions	8 .58 0	2	4.29	2.43	.1064
Error	49.42	28	1.77		
Total	124.3144				

Tukey's test shows three ranges of significance: in the first one is M-10734 (10.33); in the second one S-891 and M-10795 (11.00 seeds), M-10734 (49 seeds), S-772 (52 seeds), M-10017 (56 seeds), S-731 (57 seeds), M-10795 (58 seeds), S-867 and S-864 (59 seeds); M-10485 (62 seeds); IJ-112-97 (63 seeds); INIAP 307 (65 seeds); M-10781 (69 seeds); INIAP 308 and M-

10489 (78 seeds). The results of the controls, agree with the reports of Cortez (2010), Guamán (2014) and Santillán (2010) (Table 16).

Table 16. *Tukey's test for the weight of 100 seeds, in the adaptation and yield of Glycine max L., in Quinindé canton.*

Treatments	Averages	n		
M-10734	10.33	3	A	
S - 891	11.00	3	A	B
M-10795	11.00	3	A	B
S - 867	11.33	3	A	B
M-10485	11.67	3	A	B
S - 772	11.67	3	A	B
M-10032	11.67	3	A	B
M-10781	12.67	3	A	B
M-10489	12.67	3	A	B
IJ - 112 - 97	12.67	3	A	B
S - 864	13.00	3	A	B
S - 731	13.00	3	A	B
INIAP 307	14.00	3	A	B
INIAP 308	14.00	3	A	B
M-10017	14.67	3		B

Different letters indicate significant differences (p<=0.05).

Yield (kg ha^{-1})

The ANAVA for yield (kg ha^{-1}) indicates that there are significant differences among the treatments studied (Table 17). (Table 17)

Table 17. *ANAVA for yield (kg ha⁻¹) for the weight of 100 seeds, in the adaptation and yield of Glycine max L., in Quinindé canton.*

F.V.	SC	gl	CM	F	p-value
treatments	28831293.41	14	2059378.10	6.01	0.0001
repetitions	5242884.52 0	2	2621442.26	7.64	.0022
Error	9602004.86	28	342928.74		
Total	43676182.7944				

Tukey's test for yield (kg ha^{-1}), shows three ranges of significance: in the first is S-772 (1511.10), S-891 (1562.97), M-10485 (1847.40), M-10032 (2293.33), M-10795 (2405.90), M-10734 (2484.43), INIAP 307 (2666.63), S-731 (2742.20), S-864 (2825.17), M-10489 (2897.77), M-10781 (2905.20), S-867 (3057.77), IJ-112-97 (3118.53); in the second rank is located M-10017 (3248.90); and, the highest yield was obtained with the INIAP 308 control (4974.80). coinciding with that reported by Guamán (2010); although it differs with Santillán (2010).(Table 18).

Table 18. *Tukey's test for yield (kg ha^{-1}), in the adaptation and yield of Glycine max L., in Quinindé canton.*

Treatments	Averages	n
S - 772	1511.10	3A
S - 891	1562.97	3A
M-10485	1847.40	3A
M-10032	2293.33	3A
M-10795	2405.90	3A
M-10734	2484.43	3A
INIAP 307	2666.63	3A
S - 731	2742.20	3A

S - 864	2825.17	3A	
M-10489	2897.77	3A	
M-10781	2905.20	3A	
S - 867	3057.77	3A	
IJ - 112 - 97	3118.53	3A	
M-10017	3248.90	3A	B
INIAP 308	4974.80	3	B

Different letters indicate significant differences (p<=0.05).

Economic analysis

The economic analysis indicates that the highest profits are obtained with the materials INIAP 308 ($ 2334.89), followed by M-10017 ($ 1299.33), IJ-112-97 ($1221.11) and S-867 ($1184.67). Therefore, the materials M-10017 and S-867, indicate the convenience from the economic point of view for the soybean producer. However, evaluations are necessary, considering that edaphic and climatic factors may limit these values Guamán (2010) and Holguín (2013). (Table 19).

Table 19. *Economic analysis of the adaptation and yield of Glycine max L. in Quinindé Canton.*

TRATAM	MATER	RENDIM	COSTS	INCOME	UTILITY	Rb/c
T1	M-10781	2905.19	650.00	1743.11	1093.11	2.68
T2	S - 867	3057.78	650.00	1834.67	1184.67	2.82
T3	M-10485	1847.41	650.00	1108.44	458.44	1.71
T4	S - 864	2825.19	650.00	1695.11	1045.11	2.61
T5	M-10734	2484.44	650.00	1490.67	840.67	2.29

T6	M-10795	2405.93	650.00	1443.56	793.56	2.22
T7	S - 772	1511.11	650.00	906.67	256.67	1.39
T8	S - 731	2742.22	650.00	1645.33	995.33	2.53
T9	M-10017	3248.89	650.00	1949.33	1299.33	3.00
T10	M-10032	2293.33	650.00	1376.00	726.00	2.12
T11	M-10489	2897.78	650.00	1738.67	1088.67	2.67
T12	S - 891	1562.96	650.00	937.78	287.78	1.44
T13	IJ-112-97	3118.52	650.00	1871.11	1221.11	2.88
T14	INIAP 307	2666.67	650.00	1600.00	950.00	2.46
T15	INIAP 308	4974.81	650.00	2984.89	2334.89	4.59

Conclusions

The materials evaluated in the research showed a good response when their agronomic performance was compared with the three controls recommended by INIAP. However, differences were observed in several agronomic parameters such as days to flowering, days to maturity and harvest, plant and load height, number of branches and pods, 100-grain weight and yield. It is necessary to mention that M-10017, M-10734, M-10489, S-864 and S731 stood out for their earliness, plant height and load, yield and grain weight, and could be considered as promising in the agroecological environment of Quinindé canton, Esmeraldas province; although the yield of the INIAP-308 variety, considered as a control in this study, since it is already released for commercialization, stands out clearly, even with the different soil conditions in terms of texture and nutrient availability, which could affect the behavior of some materials.

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